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THE PERIPHYTON OF LAKE FERTŐ: SPECIES COMPOSITION AND CHLOROPHYLL-A-CONTENT

Introduction

Algological studies in the Hungarian part of Lake Fertő were this year extended to cover the periphyton as well. As it is generally known, the reed-belt of Lake Fertő is very extensive, especially on the Hungarian side. Therefore, in any floristical and ecological study the periphyton of the lake must receive primary attention. Nevertheless, mainly due to methodological difficulties, studies on the periphyton are far behind those on the plankton all over the world. This lack of knowledge is especially acute for the practical aspects of the problem, when, e.g., seeking answer to the role of the reed-belt and the periphyton in self-purification only rough estimates can be given.

We sought answer to the following questions in the course of our summer studies:

- 1) What are the species of algae found in the periphyton?
- 2) What are the dominance properties of the periphyton?
- 3) What kind of periphyton communities can be differentiated?
- 4) What is the abundance of periphyton?
- 5) Are there any floristical or numerical differences between the periphyton of the various macrophyton vegetations?
- 6) Are there any floristical or numerical differences in the periphyton from different localities?
- 7) Which of the two, the collecting locality, or the substrate vegetation has more influence over the species composition and abundance of the periphyton?

Methods

Samples of periphyton were collected between 14 and 18 July from stands of *Phragmites communis*, *Typha angustifolia*, *Schoenoplectus litoralis* and *Potamogeton pectinatus*. The collecting localities are shown in Fig. 1. In the case of *Phragmites*, *Typha* and *Schoenoplectus*, the abovewater parts were cut off. Then a tube with an inner diameter of 1,6 cm was pulled over the underwater stump, which was severed 10-16 cm below the surface. The lower end of the tube was then closed and the section of stem thus transferred to a collecting jar, which was kept in darkness during transportation. The periphyton was thoroughly washed from the section of the stem, the surface of which was calculated from its length and diameter. Pieces of *Potamogeton pectinatus* were collected without the use of glass tubes, simply by putting them in the collecting jar, taking care not to include interstitial water as well. Measurements of the breadth of the stem and leaf of *Potamogeton pectinatus* showed that it was invariably 0,8 cm, so multiplying this value by the measurements of the length of the piece, the area of the surface of stems and leaves were obtained. Sample sizes from each locality and plant species are given in Table 3. The periphyton cleaned from the macrophyton were strained on a GF/C glass filter and after solving in methanol, chlorophyll-a content was determined by spectrophotometry. The results are given as $\mu\text{g chlorophyll-a} \cdot \text{cm}^{-2}$ surface of macrophyton. Extinction was also measured at 480 nm, and from the formula

$$\text{PER} = \frac{E_{480}}{E_{666}}, \text{ the Pigment Extinction Rate (MARGALEF 1960, 1965, WINNER 1972, HAJDU et al. 1980) was calculated.}$$

One piece of macrophyton from each locality together with its periphyton were fixed in formaldehyde solution, from which the species were identified. The cell content of the diatoms was dissolved in H_2O_2 as described in HORVATH (1975). Several identification manuals (BARTHA et al. 1976, BOURRELLY 1966, 1968, 1970, FELFÖLDY 1972, 1981, HINDAK et al. 1973, HUBER PESTALOZZI 1938-1961, HUSTEDT 1930, NEMETH 1980) and other

publications (HUSTEDT 1959 a, 1959 b, 1959 c, KUSEL-FETZMANN 1974, 1979 a, 1979 b, PANTOCSEK 1912) were used during identification. The data were analysed with help of basic statistical tests and cluster analysis using JACCARD'S measure of similarity (JACCARD 1908) and UPGMA fusion algorithm (SNEATH AND SOKAL 1973).

Results and discussion

The 7 periphyton samples studied contained 214 species and subspecific taxa of algae. A list of the species and their occurrence is given in Table 1. Most of the species which are here first recorded are blue-green algae. These new records will be discussed elsewhere. Table 2. is a summary of the floristical results. Blue-green algae occurred in negligible abundance and number of species in the Rákosi Bay, which is the area on the Hungarian side more or less like the open water on the Austrian side.

The number of species increased towards the reed-belt, and it was the highest at the most southernly collecting locality. Xanthophyceae algae occurred in brown waters only. At the same time, the abundance of diatoms, except for spots of *Schoenoplectus litoralis*, was the highest in periphyton samples from Rakosi Bay. The number of species of green algae was strikingly high on stands of *Potamogeton pectinatus* in brown waters. It is remarkable that in samples from various plants but from the same locality, the pooled number of species was similar. Thus, in the Rakosi Bay, neighbouring stands of *Phragmites*, *Typha* and *Potamogeton* had numbers of periphytous algal species of 79, 84 und 82. In the Herrenlacken neighbouring stands of *Phragmites* and *Typha* contained 68 and 76 species, respectively. The number of species was lower on *Schoenoplectus litoralis* in the open water of Rakosi Bay (55), and much higher in *Potamogeton pectinatus* of the other lake with brown water, the Atjáró lake (112). The above mentioned data were subjected to cluster analysis (Fig. 2). Two similar groups can be seen on the dendrogram. One includes the samples of Rákosi Bay, the other group is made up of samples from brown waters. This phenetic grouping shows that the species composition of the periphyton is determined by the surrounding environment, rather than by the substrate vegetation.

Microscopic appearance of the periphyton from the Rákosi Bay showed the dominance of diatoms not only as regards the number of species, but also as regards abundance. The structural frame of periphyton there was made up of mucous and nonmucous diatoms (*Rhoicosphaenia*, *Gomphonema*, *Cymbella*). It is this layer that the similarity abundant *Bacillaria* were embedded in. Besides these, *Nitzschia* were common on *Phragmites*, and *Cocconeis* on *Potamogeton*. On all three species of plants, the periphyton was loosely attached to the substrate.

The periphyton of *Schoenoplectus litoralis* stands in the Rákosi Bay was strongly attached, uneven and mucous, caused by large colonies of *Gomphonema olivaceum* interspersed with *Diatoma elongatum*. The dominant species in the periphyton of the previous locality, *Rhoicosphaenia* and *Bacillaria*, occurred here in negligible numbers only. Especially the latter, but the three other periphyton samples from the Rákosi Bay were full of inorganic sestonic particles. *Cymbella*, *Gomphonema*, *Spirulina* and *Oscillatoria* were common in stands of both *Phragmites* and *Typha* in the Herrenlacken.

Achnanthes and *Spirogyra* were also found in large numbers on *Typha*. Both periphyton was strongly attached to the substrate plant, on the *Phragmites* being bark-like, on the *Typha* rather fluffly because of the filaments of *Spirogyra*.

The layer on *Potamogeton pectinatus* in the Atjârô lake was loosely attached to the plant with abundant *Cymbella* and *Oscillatoria* and many other species of algae evenly distributed in numbers.

Details of the results of the studies on the chlorophyll-a content and pigment extinction rates are given in Table 3. It may be seen in first sight that the dispersion of the chlorophyll-a data is very large. This is not so much due to the small sample sizes (except the *Typha* data from Herrenlacken), but rather due to the great

variability in abundance of the periphyton on each plant. To illustrate this, 21 chlorophyll-a measurements from the Phragmites stands in the Rákosi Bay were arranged in 5 random series of 10 samples, when the following data were obtained ($\mu\text{g chl-a} \cdot \text{cm}^2$):

	\bar{x}	s_x
1. series:	1,16	0.42
2. series:	1,02	0,47
3. series:	1,20	0.51
4. series:	1,02	0,53
5. series:	0.99	0,49

In a comparison with the above, the mean and standard error of 21 data were not significantly different ($\bar{x}=1.16$, $s_x=0,56$). In other words, the twofold increase in sample size did not lead to any decrease in the standard error. Several samples and random selection showed that the mean and standard error stabilized at sample size of 10, further on was not changed by twofold increase in sample size. This sample size seems to be optimal, especially if we take into account the amount of effort expended. I believe it is necessary to carry out studies on optimal sample sizes on the Lake Fertő.

Outlyingly high values of periphyton chlorophyll-a content were measured on stems of *Schoenoplectus litoralis* in the open water of Rákosi Bay. Here there was as much chlorophyll-a ($5 \mu\text{g} \cdot \text{cm}^{-2}$) as in plankton in one liter of water ($6 \mu\text{g} \cdot \text{l}^{-1}$). This is especially interesting since this periphyton is exposed to strong currents of the water (the *Schoenoplectus litoralis* stand was loose, with water flowing freely between the stems). The periphyton of stands of *Phragmites*, *Typha* and *Potamogeton* in the Rákosi-Bay were exposed to currents of similar strenghts. The chlorophyll-a content of the *Phragmites* periphyton was roughly twice that of the other two stands. Similar results were obtained for samples from brown waters as well. It has been shown for other lakes too, that the periphyton on *Phragmites* is more profuse than on *Typha*. The usual explanation is that the surface of *Phragmites* is more suitable for the periphyton to settle on (László TÓTH, personal communication).

Chlorophyll-a content of periphyton in stands of *Phragmites*, *Typha* and *Potamogeton* were higher in brown waters than in the Rákosi Bay.

The highest PER was measured in the periphyton of *Schoenoplectus litoralis* stands. This is probably due to the high density of periphyton and perhaps to unfavourable conditions brought about by being exposed to the effects of waves. No other significant differences were detected in the variation of PER.

It must be mentioned that in stands of *Schoenoplectus litoralis* in the Rákosi Bay, some stems, 10-20 cm lower than the others, were strikingly bare in comparison with the others. Chlorophyll-a content was only $0,88 \mu\text{g} \cdot \text{cm}^{-2}$ ($n=3$). The PER was much lower than on stems covered with periphyton (1,40). We also measured the chlorophyll-a content of two reed stems covered with *Cladophora*. As expected, it was here the largest chlorophyll-a content was measured ($9,29 \pm \mu\text{g} \cdot \text{cm}^2$, $n=2$). At the same time the PER was not significantly different from the others (1,39).

The two mean values mentioned above were not included in the calculations.

Summary

Studies carried out between 14 and 18 July 1981 on the periphyton of the Hungarian side of Lake Fertő yielded the following results:

- 1) 214 species and subspecific taxa of algae were found in 7 samples of periphyton (Cyanophyta: 44, Euglenophyta: 8, Pyrrophyta: 5, Chrysophyta: 114, Chlorophyta: 43). More species were found in brown waters than in the Rákosi-Bay.
- 2) The periphyton in the Rákosi Bay was mainly composed of diatoms, both as regards number of species and abundance. Besides these, there were many cyanophytes in lakes with brown waters. The periphyton was attached to the substrate plants in various ways, but similarly strongly in the case of *Schoenoplectus litoralis* in the Rákosi Bay, *Phragmites* and *Typha* in the Herrenlacken. The rest of the periphyton was of loose structure.

- 3) The periphyton in stands of various plant species was essentially not different floristically in a given locality.
- 4) The highest chlorophyll-a content of the periphyton in relation to the surface area of the substrate plant was measured on *Schoenoplectus litoralis*. The chlorophyll-a content in *Phragmites* was about twice that of *Typha* in the same localities. The periphyton of *Potamogeton* had chlorophyll content similar to that of *Typha*.
- 5) There were well defined floristical differences between the various collecting localities (the Rákosi Bay, open water; Rákosi Bay, edge of open water; Herrenlacken; Átjaró Lake) as shown by cluster analysis.
- 6) The chlorophyll-a content was higher in the periphyton of the three studied substrate species in lakes with brown water than in the Rákosi Bay.

The studies presented here show that the species composition of the periphyton is determined primarily by the characters of the locality. At several points, further studies are needed to supplement the results presented here. We have no data, e.g. on the seasonal variation in the quantity and quality of the periphyton. The simultaneous presence of dense and thin patches of periphyton on *Schoenoplectus litoralis* indicates that there may be sensitive periods for the colonialization by the periphyton. Such a study would be of interest and a very important aspect of the research. It is certain, that investigations should be extended to cover other parts of the Hungarian side of the lake, and also to other species of substrate plants. Another problem to be studied: why and when is the periphyton of *Phragmites* more developed than that of *Typha*. Also, we do not know the functional parameters

of the periphyton in the Lake Fertő. Further studies are aimed at in these directions.

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Zusammenfassung

Die Periphyton-Untersuchungen - die im ungarischen Teil des Fertő (Neusiedlersee) in der Zwischenzeit vom 14. bis 18. Juli 1981 durchgeführt wurden - ergaben folgende Ergebnisse.

- 1) Aus den 7 Periphyton-Proben wurden insgesamt 214 Arten bzw. subspezifische Taxa beschrieben (Cyanophyten: 44, Euglenophyten: 8, Pyrrophyten: 5, Chrysophyten: 114, Chlorophyten: 4³). Aus den Braungewässern konnten insgesamt mehr Algen-Arten nachgewiesen werden, als aus der Rákoser Bucht.
- 2) Das Periphyton der Rákoser Bucht birgt - arten- und zahlenmässig - größtenteils Kieselalgen. In den Braungewässern waren außer diesen noch zahlreiche Cyanophyten anzutreffen. In der Rákoser Bucht ist das Periphyton abweichend, aber gleicherweise eng mit *Schoenoplectus litoralis* verbunden, in den Braungewässern mit *Phragmites* und *Typha*. Das übrige Periphyton bildet lockeres Gefüge.
- 3) An gleichen Sammelstellen konnte an dem an verschiedene Pflanzenarten gebundenen Periphyton kein wesentlicher floristischer Unterschied nachgewiesen werden.
- 4) Der höchste Chlorophyll-a-Gehalt des Periphytons wurde - auf Flächeneinheit der Substratpflanze berechnet - an *Schoenoplectus litoralis* gemessen. Der Chlorophyll-a-Gehalt der *Phragmites*- und der *Typha*-Bestände von gleicher Exposition erwies sich bei *Phragmites*

doppelt so hoch als bei Typha. Der Chlorophyll-Gehalt des Potamogeton-Periphytons war dem der Typha gleich.

- 5) Zwischen den aus verschiedenen Teilen des Sees (Rákoser Bucht, offenes Wasser; - Rákoser Bucht, Saum des offenen Wassers; - kleiner Herlacken; - Durchgangs-See) gesammelten Periphyton-Material konnten nennenswerte floristische Unterschiede verzeichnet werden, die auch mit der Cluster-Analyse erwiesen wurden. In den Braungewässern war der Chlorophyll-Gehalt bei allen drei verglichenen Pflanzenarten höher als in der Rákoser Bucht.

Unsere, aus verschiedener Sicht gewerteten Untersuchungen weisen darauf hin, daß die Artenzusammensetzung des Periphytons ausschlaggebend vom Charakter der Sammelstellen beeinflußt wird, wobei die Artenzugehörigkeit der Substratpflanze nur von sekundärer Bedeutung ist.

Die weiter oben angeführten Untersuchungen und deren Ergebnisse müssen noch an verschiedenen Stellen ergänzt werden. So stehen uns z.B. über die quantitative und qualitative saisonale Gestaltung des Periphytons überhaupt keine Angaben zur Verfügung. Das gleichzeitig sehr dichte, teilweise aber sehr spärliche Periphyton des Schoenoplectus litoralis in der Rákoser Bucht weist darauf hin, daß während der Kolonization besonders empfindliche Perioden bestehen können, deren Erkundung eine interessante und wichtige Forschungsaufgabe darstellt.

Allenfalls steht es fest, daß die Aufsammlungen auch an anderen Abschnitten des ungarischen Seegebietes, und auch an anderen Substratpflanzen durchgeführt werden müssen. Ein weiteres Problem das ebenfalls geklärt werden sollte ist die Frage: weshalb und von welchem Zeit-Faktor beeinflußt das Periphyton am Phragmites mehr entwickelt ist als auf Typha. Auch die Wirkungsparametern des Periphytons am Neusiedlersee sind uns unbekannt. In der Zukunft sind wir bestrebt diese Probleme zu lösen.

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Table 1

Rákosi-Bay

Brown-water
lakes

List of the species found in the sample
of periphyton from 7 localities collected between 14
and 18 July 1981 in the Hungarian side of Lake Fertő

Phragmites communis	Typha angustifolia	Schoenoplectus littoralis	Potamogeton pectinatus	Phragmites communis	Typha angustifolia	Potamogeton pectinatus
1.	2.	3.	4.	5.	6.	7.

Cyanophyta

Chroococcales

1. Aphanothece clathrata W. et G.S. West				+	+	
2. Chroococcus minutus var. obliterated /Richt./Hansg.				+	+	+
3. Chroococcus turgidus /Kg./ Naeg.				+	+	
4. Dactylococcopsis acicularis Lemm.				+		
5. Dactylococcopsis raphidioides Hansg.				+		+
6. Gomphosphaeria lacustris Chodat.			+			+
7. Merismopedia glauca /Ehr./ Naeg.				+	+	+
8. Merismopedia marssonii Lemm.						+
9. Merismopedia punctata Mey.			+	+	+	+
10. Merismopedia trollerii Bachm.						+
11. Microcystis firma /Bréb. et Lenorm./ Schmidle					+	
12. Microcystis flos-aquae /Wittr./ Kirchn.			+			
13. Microcystis pulvera /Wood/ Forti						+
14. Rhabdonema lineare Schmidle et Lauterb.					+	+
15. Synechococcus cedrorum Sauv.					+	+
16. Synechocystis salina Wisl.						+

Hormogonales

17. Anabaena constricta /Szaf./ Geitl.					+	+
18. Anabaena viguiérii Denis et Frémy					+	
19. Lyngbya cryptovaginata Schkorb.			+	+	+	+
20. Lyngbya hyeronimusii Lemm.		+			+	+
21. Lyngbya kuetzingii Schmidle					+	+
22. Lyngbya limnetica Lemm.	+	+	+	+	+	+
23. Lyngbya marteisiana Menegh.						+
24. Oscillatoria acutissima Kuff.					+	
25. Oscillatoria agardhii Gom.			+			
26. Oscillatoria amphybia Agh.					+	+
27. Oscillatoria articulata Gardn.	+		+		+	
28. Oscillatoria chalybea /Mert./ Gom.					+	
29. Oscillatoria geminata Menegh.						+
30. Oscillatoria granulata Gardn.			+		+	+
31. Oscillatoria guttulata van Goor	+				+	
32. Oscillatoria limosa Agh.					+	

Table 1 (cont.)

1. 2. 3. 4. 5. 6. 7.

33. <i>Oscillatoria mougeotii</i> Kg.	+	+					+
34. <i>Oscillatoria neglecta</i> Lemm.					+		
35. <i>Oscillatoria planctonica</i> Wolosz.					+		
36. <i>Oscillatoria rubescens</i> D. C.					+		
37. <i>Oscillatoria sancta</i> /Kg./ Gom.					+	+	
38. <i>Oscillatoria tenuis</i> Agh.		+		+	+	+	+
39. <i>Pseudanabaena catenata</i> Lauterb.					+	+	+
40. <i>Spirulina abbreviata</i> Lemm.							+
41. <i>Spirulina laxissima</i> G. S. West					+		+
42. <i>Spirulina maior</i> Kg.					+		
43. <i>Spirulina subsalsa</i> Oerst.	+	+	+	+	+	+	+
44. <i>Spirulina subtilissima</i> Kg.	+		+	+	+	+	

Euglenophyta

45. <i>Euglena</i> sp.		+	+	+		+	+
46. <i>Euglena gracilis</i> Klebs							+
47. <i>Euglena oxyuris</i> Schmarida		+	+				
48. <i>Euglena tripteris</i> /Duj./ Klebs	+			+			
49. <i>Phacus curvicauda</i> Pochm.	+	+			+	+	
50. <i>Phacus pleuronectes</i> /O.F.M./ Duj.		+					+
51. <i>Phacus pusillus</i> Lemm.				+			
52. <i>Trachelomonas</i> sp.						+	

Pyrrophyta

Cryptophyceae							
53. <i>Cryptomonas</i> sp.	+				+		+
Dinophyceae							
54. <i>Gymnodinium paradoxiforme</i> Schiller							+
55. <i>Peridinium</i> sp.						+	
56. <i>Peridinium cinctum</i> /Mueller/ Ehr.							+
57. <i>Peridinium inconspicuum</i> Lemm.							+

Chrysophyta

Xanthophyceae							
58. <i>Goniochlorys spinosa</i> Pasch.							+
59. <i>Ophiocytium capitatum</i> Wolle						+	
60. <i>Ophiocytium cochleare</i> A. Br.						+	+
61. <i>Ophiocytium majus</i> Naeg.							+
Bacillariophyceae							
62. <i>Achnanthes brevipes</i> var. <i>intermedia</i> /Kuetz./ Cleve	+	+		+			+
63. <i>Achnanthes delicatula</i> Kuetz.			+				
64. <i>Achnanthes lanceolata</i> Bréb.	+	+		+			
65. <i>Achnanthes lanceolata</i> var. <i>elliptica</i> Cleve	+		+	+			
66. <i>Achnanthes minutissima</i> Kuetz.	+	+	+	+	+	+	+
67. <i>Amphiprora costata</i> Hust.		+					
68. <i>Amphiprora paludosa</i> W. Smith	+	+	+	+	+	+	+
69. <i>Amphora coffeaeformis</i> Agardh.							+
70. <i>Amphora commutata</i> Grun.		+					
71. <i>Amphora ovalis</i> Kuetz.	+	+		+	+	+	+
72. <i>Amphora ovalis</i> var. <i>pediculus</i> Kuetz.	+	+	+	+		+	+
73. <i>Anomoeoneis sphaerophora</i> var. <i>sculpta</i> /Ehr./ O. Muell.						+	+
74. <i>Bacillaria paradoxa</i> Gmelin	+	+	+	+	+		

Table 1 (cont.)

	1.	2.	3.	4.	5.	6.	7.
75. <i>Caloneis amphisbaena</i> /Bory/ Cleve	+			+			
76. <i>Caloneis permagna</i> /Bailey/ Cleve	+			+			
77. <i>Caloneis silicula</i> var. <i>peisonis</i> Hust.					+	+	+
78. <i>Campylodiscus clypeus</i> Ehr.	+	+	+	+	+	+	+
79. <i>Campylodiscus clypeus</i> var. <i>bicostatus</i> /W. Smith/ Hust.	+	+		+	+	+	+
80. <i>Cocconeis pediculus</i> Ehr.	+	+	+	+			
81. <i>Cocconeis placentula</i> Ehr.	+	+	+	+	+		+
82. <i>Cocconeis placentula</i> var. <i>euglypta</i> /Ehr./ Cleve		+	+	+		+	+
83. <i>Cocconeis placentula</i> var. <i>lineata</i> /Ehr./ Cleve							+
84. <i>Cyclotella comta</i> /Ehr./ Kuetz.			+				+
85. <i>Cyclotella meneghiniana</i> Kuetz.	+	+	+	+	+	+	+
86. <i>Cyclotella ocellata</i> Pant.	+	+					
87. <i>Cymatopleura elliptica</i> /Bréb./ W. Smith		+		+			
88. <i>Cymatopleura elliptica</i> var. <i>constricta</i> /Grun./	+	+					
89. <i>Cymatopleura solea</i> /Bréb./ W. Smith		+		+			
90. <i>Cymbella affinis</i> Kuetz.	+	+	+	+	+		+
91. <i>Cymbella aspera</i> /Ehr./ Cleve		+					+
92. <i>Cymbella cistula</i> /Hemprich/ Grun.	+	+	+	+	+	+	+
93. <i>Cymbella lacustris</i> /Agardh/ Cleve		+		+	+		
94. <i>Cymbella lanceolata</i> /Ehr./ v. Heurck	+			+			
95. <i>Cymbella pusilla</i> Grun.		+			+	+	+
96. <i>Cymbella ventricosa</i> Kuetz.							+
97. <i>Diatoma elongatum</i> Agardh	+	+	+	+	+		
98. <i>Diatoma elongatum</i> var. <i>minor</i> Grun.	+						
99. <i>Diatoma elongatum</i> var. <i>tenuis</i> /Agardh/ Kuetz.	+	+		+			
100. <i>Epithemia sorex</i> Kuetz.		+		+			
101. <i>Epithemia turgida</i> /Ehr./ Kuetz.		+					
102. <i>Epithemia zebra</i> /Ehr./ Kuetz.					+	+	+
103. <i>Epithemia zebra</i> var. <i>porcellus</i> /Kuetz./ Grun.	+	+		+			
104. <i>Epithemia zebra</i> var. <i>saxonica</i> /Kuetz./Grun.							+
105. <i>Eunotia lunaris</i> /Ehr./ Grun.							+
106. <i>Eunotia lunaris</i> var. <i>capitata</i> Grun.							+
107. <i>Fragilaria brevistriata</i> Grun.							+
108. <i>Fragilaria brevistriata</i> var. <i>inflata</i> /Pant./ Hust.			+				
109. <i>Fragilaria capucina</i> Desmazières							+
110. <i>Gomphonema acuminatum</i> Ehr.							+
111. <i>Gomphonema acuminatum</i> var. <i>brébissonii</i> /Kuetz./ Cleve	+	+		+			
112. <i>Gomphonema acuminatum</i> var. <i>trigonocephala</i> /Ehr./ Grun.		+				+	
113. <i>Gomphonema constrictum</i> Ehr.						+	
114. <i>Gomphonema constrictum</i> var. <i>capitatum</i> /Ehr./ Cleve	+		+		+	+	+
115. <i>Gomphonema longiceps</i> Ehr.					+		
116. <i>Gomphonema longiceps</i> var. <i>subclavatum</i> Grun.						+	
117. <i>Gomphonema longiceps</i> f. <i>suecica</i> Grun.	+	+		+		+	+
118. <i>Gomphonema olivaceum</i> /Lyngb./ Kuetz.	+	+	+	+			+
119. <i>Gomphonema olivaceum</i> var. <i>calcareum</i> Cleve	+	+	+		+	+	+
120. <i>Gyrosigma spencerii</i> /W. Smith/ Cleve	+	+		+			
121. <i>Hantzschia amphioxys</i> /Ehr./ Grun.				+			
122. <i>Mastoglia smithii</i> var. <i>amphicephala</i> Grun.				+	+		+
123. <i>Melosira varians</i> C. A. Ag.	+	+		+			

	1.	2.	3.	4.	5.	6.	7.
124. <i>Navicula cryptocephala</i> Kuetz.	+	+	+	+	+	+	+
125. <i>Navicula cuspidata</i> Kuetz.	+	+			+	+	+
126. <i>Navicula cuspidata</i> var. <i>ambigua</i> /Ehr./ Cleve				+			
127. <i>Navicula dicephala</i> /Ehr./ W. Smith	+		+	+		+	+
128. <i>Navicula gracilis</i> Ehr.	+	+	+	+			+
129. <i>Navicula halophyla</i> Hust.						+	+
130. <i>Navicula oblonga</i> Kuetz.	+			+	+	+	+
131. <i>Navicula protracta</i> Grun.						+	
132. <i>Navicula pupula</i> var. <i>capitata</i> Hust.	+				+	+	+
133. <i>Navicula radiosa</i> Kuetz.	+	+		+	+	+	+
134. <i>Navicula radiosa</i> var. <i>tenella</i> /Bréb./ Grun.	+	+	+	+			+
135. <i>Navicula stundlii</i> Hust.			+				
136. <i>Navicula tenuipunctata</i> Hust.			+			+	
137. <i>Nitzschia acicularoides</i> Hust.		+	+	+			
138. <i>Nitzschia amphibia</i> Grun.							+
139. <i>Nitzschia filiformis</i> /W. Smith/ Hust.		+	+	+		+	
140. <i>Nitzschia geitlerii</i> Hust.				+	+		+
141. <i>Nitzschia hungarica</i> Grun.	+	+		+			+
142. <i>Nitzschia hybrida</i> Grun.	+	+					
143. <i>Nitzschia kuetzigiana</i> Hilse	+			+			
144. <i>Nitzschia kuetzingioides</i> Hust.				+			
145. <i>Nitzschia leglerii</i> Hust.				+		+	
146. <i>Nitzschia lorenziana</i> var. <i>subtilis</i> Grun.	+	+	+	+			
147. <i>Nitzschia sigma</i> /Kuetz./ W. Smith		+					
148. <i>Nitzschia sigmoidea</i> /Ehr./ W. Smith	+	+		+	+	+	+
149. <i>Nitzschia spectabilis</i> /Ehr./ Ralfs.	+						
150. <i>Nitzschia sublinearis</i> Hust.							+
151. <i>Nitzschia tryblionella</i> Hantzsch	+	+		+			
152. <i>Nitzschia tryblionella</i> var. <i>debilis</i> /Arnott/ A. Mayer	+	+	+	+			
153. <i>Nitzschia tryblionella</i> var. <i>levidiensis</i> /W. Smith/ Grun.							+
154. <i>Pinnularia microstauron</i> var. <i>brébissonii</i> /Kuetz./ Hust.					+	+	
155. <i>Pinnularia molaris</i> Grun.	+						
156. <i>Rhoicosphaenia curvata</i> /Kuetz./ Grun.	+	+	+	+	+	+	+
157. <i>Rhopalodia gibba</i> /Ehr./ O. Muell.	+	+	+	+	+	+	+
158. <i>Rhopalodia gibba</i> var. <i>ventricosa</i> /Ehr./ Grun.		+					
159. <i>Rhopalodia gibberula</i> /Ehr./ O. Muell.		+					
160. <i>Surirella hoeflerii</i> Hust.	+		+	+			
161. <i>Surirella ovalis</i> Bréb.	+						
162. <i>Surirella ovata</i> Kuetz.	+	+	+	+			
163. <i>Surirella peisonis</i> Pant.	+	+	+	+	+		
164. <i>Synedra acus</i> var. <i>radians</i> /Kuetz./ Hust.	+	+	+	+	+	+	+
165. <i>Synedra capitata</i> Ehr.		+			+	+	+
166. <i>Synedra pulchella</i> Kuetz.				+			
167. <i>Synedra ulna</i> /Nitzsch/ Ehr.	+	+	+	+	+	+	+
168. <i>Synedra ulna</i> var. <i>biceps</i> /Kuetz./v. Schönf.	+	+	+	+	+	+	+
169. <i>Synedra ulna</i> var. <i>spatulifera</i> Grun.							+
170. <i>Synedra vaucheriae</i> Kuetz.		+		+			
171. <i>Synedra vaucheriae</i> var. <i>truncata</i> /Greville/ Grun.		+					

L o r o p h y t a

172. <i>Volvocales</i>							
173. <i>Chlamydomonas</i> sp.					+		
173. <i>Pandorina morum</i> /Muell./ Bory							+

Chlorococcales

174.	Ankistrodesmus angustus Bern.	+		+	+		
175.	Ankistrodesmus fusiformis Corda sensu Kors.						+
176.	Ankistrodesmus pseudobraunii Belch. et Sw. non Kiss	+	+			+	+
177.	Crucigenia quadrata Morren	+	+	+			
178.	Elakatothrix lacustris Kors.						+
179.	Hyaloraphidium contortum Pascher et Kors.					+	
180.	Oocystis sp.	+	+				+
181.	Oocystis lacustris Chod.	+			+		
182.	Pediastrum boryanum /Turp./ Menegh.				+		
183.	Pediastrum duplex Meyen	+	+	+	+		
184.	Scenedesmus acutus Meyen						+
185.	Scenedesmus bicaudatus /Hansg./ Chod.						+
186.	Scenedesmus ecornis /Ralfs./ Chod.						+
187.	Scenedesmus ecornis var. disciformis Chod.						+
188.	Scenedesmus intermedius Chod.				+	+	
189.	Scenedesmus quadricauda /Turp./ Bréb.	+	+			+	+
190.	Schroederia nitzschoides /G. S. West/ Kors.	+	+	+			
191.	Schroederia robusta Kors.	+			+		
192.	Schroederia setigera /Schroed./ Lemm.	+		+	+		
193.	Selenastrum bibrasianum Reinsch.						+
194.	Tetraedron minimum /A. Br./ Hansg.						+
195.	Tetraedron minimum var. tetralobulatum Reinsch.						+
196.	Tetraedron quadratum /Reinsch./ Hansg.						+
Ulotrichales							
197.	Oedogonium sp.	+					+
198.	Ulothrix sp.				+	+	
Zygnematales							
199.	Spirogyra sp.	+		+		+	+
Desmidiaceales							
200.	Closterium aciculare Hantzsch						+
201.	Closterium dianae Ehr.	+			+		+
202.	Closterium parvulum Naeg.		+	+	+		
203.	Cosmarium biretum var. trigibberum Nordst.					+	+
204.	Cosmarium bortytis Menegh.					+	+
205.	Cosmarium clepsydra var. bicardia /Reinsch./ Croesd.	+					
206.	Cosmarium depressum /Naeg./ Lund.	+	+				
207.	Cosmarium granatum Bréb.						+
208.	Cosmarium humile var. glabrum Gutw.						+
209.	Cosmarium praecisum var. suecicum /Borge/ Krieg.						+
210.	Cosmarium scopulorum Borge	+					+
211.	Cosmarium umbilicatum Lütke.						+
212.	Cosmarium varsoviense Racib.						+
213.	Staurostrum alternans Bréb.						+
214.	Staurostrum hexacerum /Ehr./ Wittr.	+			+		

Table 2

Number of species found in
periphyton on the Hungarian
side of Lake Fertő between
14 and 18 July 1981

	Rákosi-Bay				Brown-water lakes		
	Phragmites communis	Typha angustifolia	Schoenoplectus litoralis	Potamogeton pectinatus	Phragmites communis	Typha angustifolia	Potamogeton pectinatus
Cyanophyta	6	7	6	7	26	22	24
Chroococcales	-	2	-	1	8	8	10
Hormogonales	6	5	6	6	18	14	14
Euglenophyta	2	4	2	3	1	3	3
Pyrrophyta	1	-	-	-	1	1	4
Cryptophyceae	1	-	-	-	1	-	1
Dinophyceae	-	-	-	-	-	1	3
Chrysophyta	57	62	37	61	34	41	56
Xanthophyceae	-	-	-	-	-	2	3
Bacillariophyceae	57	62	37	61	34	39	53
Chlorophyta	13	11	10	11	6	9	25
Volvocales	-	-	1	-	-	-	1
Chlorococcales	9	7	5	7	3	5	12
Ulotrichales	1	-	1	1	-	-	1
Zygnematales	1	-	1	-	1	1	1
Desmidiaceae	2	4	2	3	2	3	10
Total	79	84	55	82	68	76	112

Table 3

		number of samples	chlorophyll-a conc. $\mu\text{g} \cdot \text{cm}^{-2}$ \bar{x} s_x	$\frac{E_{480}}{E_{666}}$ \bar{y} s_y
Brown-water Rákosi-Bay lakes	Phragmites communis	21	1.16 · 0.56	1.40 0.09
	Typha angustifolia	19	0.49 0.32	1.43 0.08
	Schoenoplectus litoralis	7	5.03 1.68	1.70 0.75
	Potamogeton pectinatus	20	0.56 0.18	1.55 0.08
	Phragmites communis	10	2.33 0.80	1.59 0.26
	Typha angustifolia	5	1.38 0.67	1.32 0.05
	Potamogeton pectinatus	10	1.26 0.40	1.42 0.22

Variation in chlorophyll-a content of periphyton
in the Hungarian part of Lake Fertő between 14 and
18 July

RÁKOSI-BAY

Schoenoplectus litoralis
Phragmites communis
Typha angustifolia
Potamogeton pectinatus

HERRENLACKEN

Phragmites communis
Typha angustifolia

LAKE ÁTJÁRÓ

Potamogeton pectinatus

Figure 1

Sampling localities of periphyton
collected between 14 and 18 July 1981
in the Hungarian part of Lake Fertő

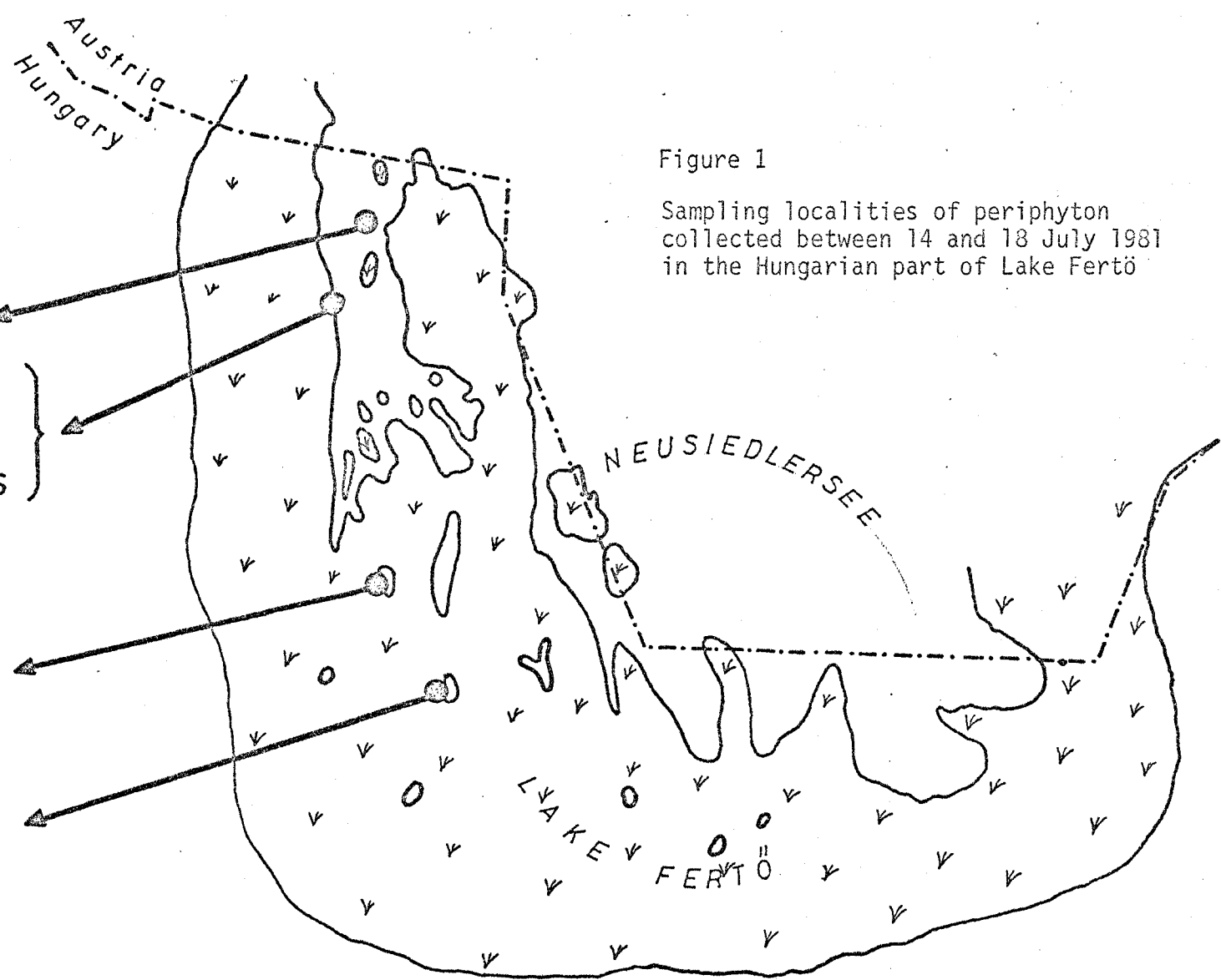
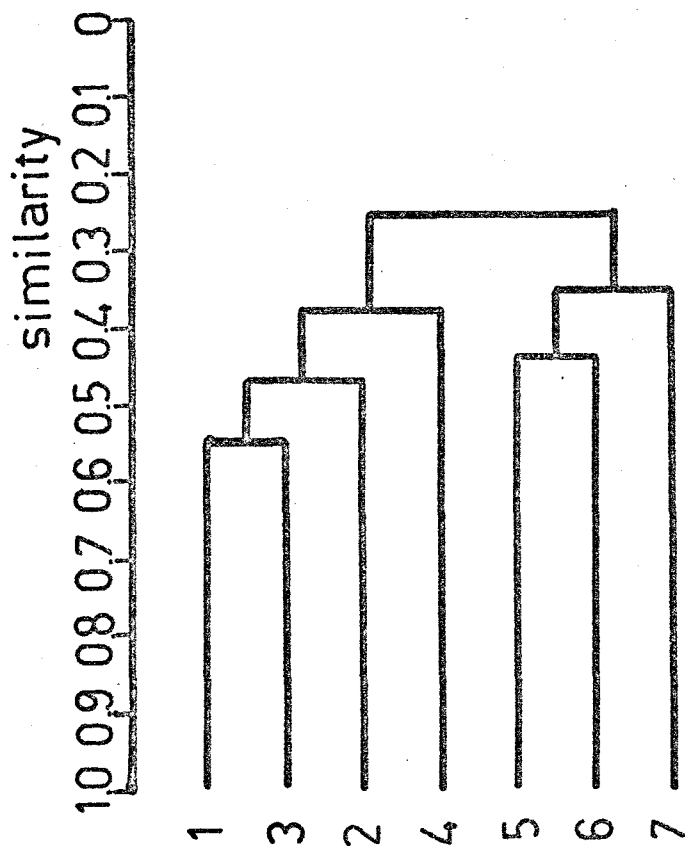


Fig. 2



Dendrogram of cluster analysis of algological data of periphyton collected between 14 and 18 July 1981 from Lake Fertő (1.: *Phragmites communis*, Rákosi Bay; 2.: *Typha angustifolia*, Rákosi Bay; 3.: *Potamogeton pectinatus*, Rákosi Bay; 4.: *Schoenoplectus litoralis*, Rákosi Bay; 5.: *Phragmites communis*, Herrenlacken; 6. *Typha angustifolia*, Herrenlacken; 7.: *Potamogeton pectinatus*, Lake Atjärö)